Boll. Malacol., 40 (9-12): 95-100 (2004)

Considerations on a population of the endangered marine mollusc *Patella ferruginea* Gmelin, 1791 (Gastropoda, Patellidae) in the Cala Iris islet (National Park of Al Hoceima - Morocco, Alboran sea)

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Abstract

The limpet *Patella ferruginea* is an endemic Mediterranean species threatened by extinction. Therefore, in a conservation approach, it is of great importance to identify and quantify the structure of its remaining populations. The study, conducted in September 2002 within the MedMPA project, revealed the presence of a large population of *Patella ferruginea* within the National Park of Al Hoceima and in particular on the Cala Iris Islet. In this site, the population seems to be well-established with a specimen density of 0.23 ind./m and a maximum length of 90 mm. The relevance of the study area for *P. ferruginea* points out the need of further specific research activities to draw a management and monitoring plan to adequately protect this endangered species in the National Park of Al Hoceima.

Riassunto

Patella ferruginea è una specie endemica del Mediterraneo, a rischio di estinzione. In un'ottica conservazionistica, è dunque importante identificare e quantificare le popolazioni esistenti. Le attività di rilevamento condotte nel mese di settembre del 2002 nell'ambito del progetto MedMPA, hanno consentito di registrare la presenza di una considerevole popolazione di *P. ferruginea* lungo le coste del Parco Nazionale di Al Hoceima ed in particolare sull'isolotto di Cala Iris. In questo sito la popolazione sembra essere ben insediata con una densità di 0.23 ind./m e caratterizzata da individui di lunghezza massima pari a 90 mm. La presenza di *P. ferruginea* in quest'area evidenzia la necessità di future attività di ricerca finalizzate alla definizione di un piano di monitoraggio e di gestione al fine di proteggere in modo efficace questa specie nelle acque del Parco Nazionale di Al Hoceima.

Key words

Patella ferruginea, Mollusc, endangered species, National Park of Al Hoceima, Alboran Sea.

Introduction

The limpet *Patella ferruginea* Gmelin, 1791 is the biggest species of the Mediterranean patellids (Boudouresque, 1996). This endemic species, formerly widespread in almost all of the western Mediterranean, is currently very rare and is considered a relict species with restricted population nuclei (Cretella *et al.*, 1994). It has been observed on the coast of Corsica, Sardinia, southern Spain and north Africa (Maurin *et al.*, 1994) and represents the most endangered marine invertebrate of the western Mediterranean (Laborel-Deguen & Laborel, 1991a; Ramos, 1998).

The presence of *Patella ferruginea* along the Mediterranean Moroccan coast has been reported in many locations: Ceuta (Fisher-Piette, 1959; Guerra-Garcia *et al.*, 2004), M'diq bay (Laborel-Deguen & Laborel, 1991a), Restinga, Cabo Negro and Oued Laou (Muniz-Solis, 1972), Melilla (Templado, 2001) and Chafarinas Islands (Pallary, 1912-1920; Grandfils, 1982; Aparicio-Seguer *et al.*, 1995). On the Moroccan Atlantic coast, the species was also reported by several authors (Biagi & Poli, 1986; Cretella *et al.*, 1994) but no exact localities are given. Pallary (1902) signals the species in Tangier but does not include this citation in his work on the whole Moroccan coasts in 1912-1920. Fisher-Piette (1959) did not detect the species on the Atlantic coast of Morocco during a sampling program on intertidal areas of the Strait of Gibraltar. Recent preliminary data, highlight new locations on the Mediterranean coast of Morocco characterised by *P. ferruginea* presence (Bazaïri & Benhissoune, 2004). **Fig. 1** illustrates 13 locations where the presence of the species is confirmed, 7 of which are recent data (Bazaïri & Benhissoune, 2004). Most of these locations, with the exception of Ceuta (Guerra-Garcia *et al.* 2004) and Chafarinas Islands (Grandfils, 1982; Aparicio-Seguer *et al.*, 1995), have not been studied in terms of the structure and the size of these relict populations.

The main threats considered responsible for the species' decline of *Patella ferruginea* are its use as food, fishing bait and as a collector's item (Ramos, 1998; Laborel-Deguen & Laborel, 1991 a-b; Templado, 2001; Guerra-Garcia *et al.*, 2004). The marked reduction of *Patella ferruginea* throughout its range highlight the need for a conservation approach which should include, amongst others, the quantification of the remaining populations and of their structures. This contribution regards the information collected on the presence

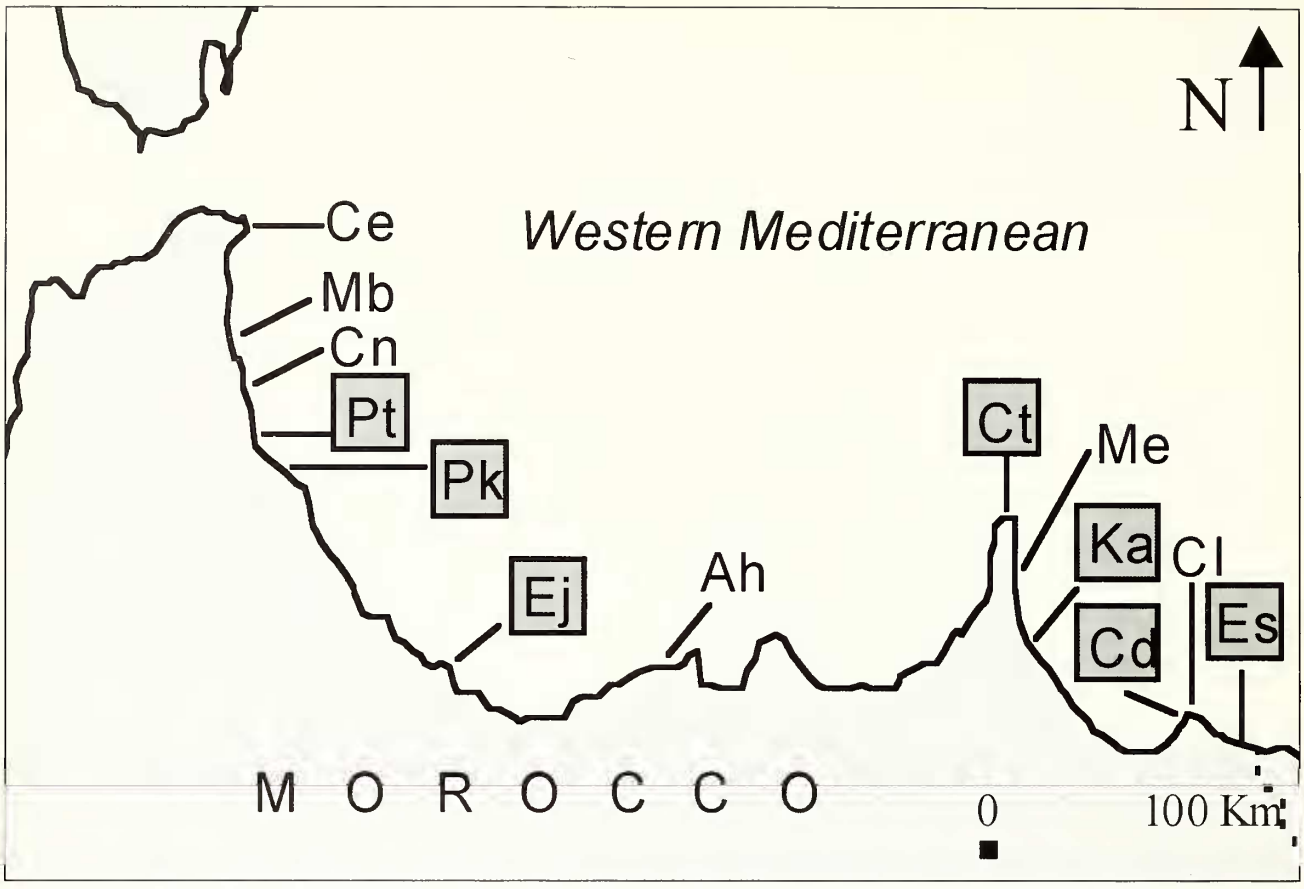

Fig. 1. Distribution of *Patella ferruginea* along the Moroccan Mediterranean. Shaded letters indicate localities where *Patella ferruginea* was recently recorded (after Bazairi & Benhissoune, 2004). Ce = Ceuta; Mb = Mdiq bay; Cn = Cabo negro; Pt = Pointe Targha; PK = Pointe Mekkad; Ej = El Jabha; Ah = Al Hoceima; Ct = Cap des Trois Fourches; Me = Melilla; Ka = Karyat Arekmane; Cd = Cap de l'Eau; Cl = Chafarinas Islands; Es = Essaidia.

Fig. 1. Distribuzione di *Patella ferruginea* lungo le coste marrocchine del Mediterraneo. Le lettere nei quadrati in grigio indicano le località dove *Patella ferruginea* è stata ritrovata recentemente (da Bazairi & Benhissoune, 2004). Ce = Ceuta; Mb = Mdiq bay; Cn = Cabo negro; Pt = Pointe Targha; PK = Pointe Mekkad; Ej = El Jabha; Ah = Al Hoceima; Ct = Cap des Trois Fourches; Me = Melilla; Ka = Karyat Arekmane; Cd = Cap de l'Eau; Cl = Chafarinas Islands; Es = Essaidia.

of the species inside the National Park of Al Hoceima (Morocco) with particular regards to the structure of the Cala Iris Islet population.

Material and Methods

Fieldwork was carried out in September 2002, within the framework of the MedMPA project, funded by the European Union and coordinated by RAC/SPA (Regional Activity Center for Specially Protected Areas). The aim of the MedMPA project was that of collecting data useful in the elaboration of the zoning proposal and management plan for the marine part of the National Park of Al Hoceima.

The National Park of Al Hoceima is located on the Mediterranean Moroccan coast, 150 km east from the Gibraltar Strait, in proximity to the city of Al Hoceima and has a 47 km long coastline (**Fig. 2**). The park encompasses several environments of high biological value. The coast is dominated by rocky impervious cliffs reaching up to 600m and by some islets. The Cala Iris Islet considered in this study is situated some 500 m off the Cala Iris beach, in the eastern limit of the Park (Fig. 2).

The presence of *Patella ferruginea* within the National Park of Al Hoceima, was investigated by inspecting the whole coastal stretch (extending from Pointe Boussekour until Cala Iris) by boat/zodiac and taking note of the presence or absence of individuals. A systematic and more detailed census was carried out on the limpet population present on Cala Iris Islet. The survey was carried out by two people swimming alongside the coast.

The coastal length (meters) of the island and its different sectors of exposure were measured through the use of a Geographic Information System (G.I.S.). The GIS software used is Arcview (ESRI). The coastline was digitised based on the Moroccan Geographic Marine Institute map (1:50000 scale). The islet's perimeter was divided according to the different geomorphological units observed.

Estimates on the species' density (n. of specimens/m) were calculated by considering the lengths of the different sectors of exposure measured through GIS. Density values were obtained by considering only the rocky sectors. A χ^2 on the specimen number per 100 m of coast was run so as to compare the density against the exposure of the coastal stretch.

For biometrics characterisation, the size of the limpets was taken by measuring the length (widest diameter) and width (narrowest diameter) of every shell using a vernier calliper with a precision of 0.1mm. Size frequency distribution around the islet was plotted using histograms. Regressions between length and width were calculated using the $Y = aX + b$ linear model. The influence of the islet exposure (north, east and west) on specimen size was analysed using one-way ANOVA.

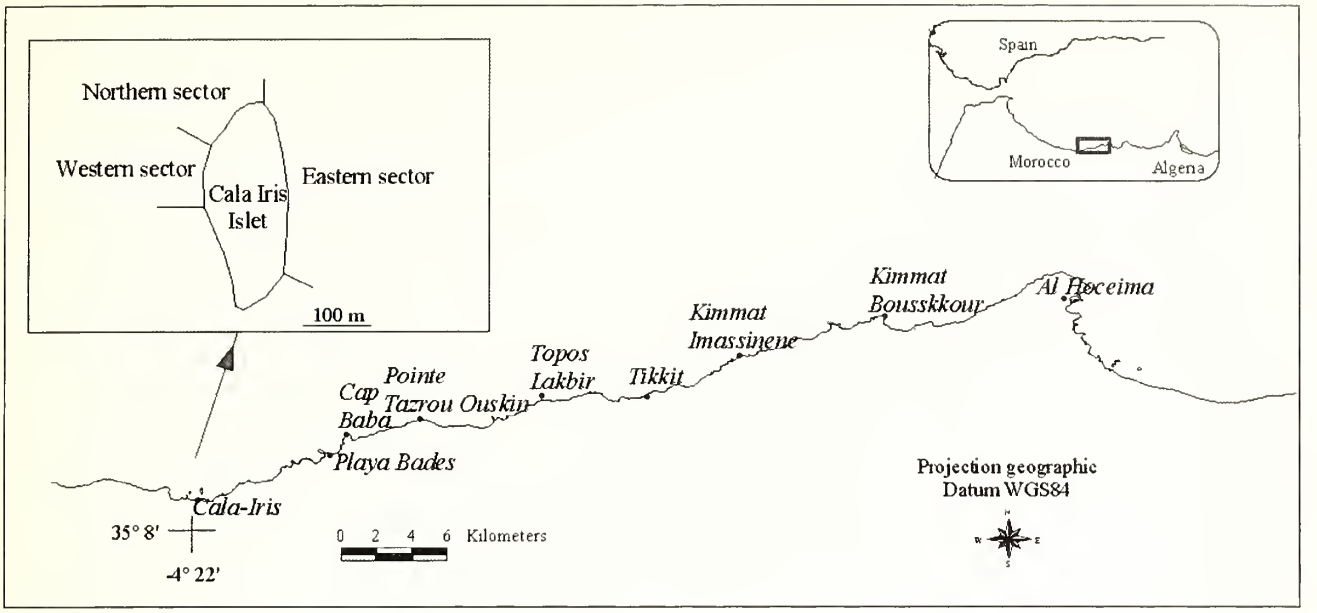

Fig. 2. Map showing the location of the National Park of Al Hoceima and the Cala Iris Islet.

Fig. 2. Ubicazione del Parco Nazionale di Al Hoceima e dell'isoletta di Cala Iris.

Results

The preliminary survey of the study area indicated the presence of *P. ferruginea* throughout the Park. Nevertheless, no data are available regarding the size and the structure of the population recorded along the whole coastal stretch.

The Cala Iris Islet has a perimeter of 702 m, of which 65% are rocky coast (N sector 15%, NE sector 37 % and NW sector 13%) favourable to *P. ferruginea* settlement. The remaining portions of the island are characterised by low sandy or pebble bottoms.

The distribution of the limpets along the island's rocky sectors was not homogenous. The greater part of the population was concentrated in its northern middle part. 110 specimens of *Patella ferruginea* were recorded in total on the islet. Their length ranged between 15 and 90 mm (mean = 46.0 ± 1.49 mm), with the most number of individuals falling in the length interval 30-50 mm. The width of the individuals varied between 10 and 71 mm (mean = 35.8 ± 1.26 mm), with the highest number of individuals falling in the width interval 30-40 mm (**Fig. 3**). The analysis of the frequency distribution of both the length and width of the shells/sector highlights different patterns. Indeed, the length of the specimens showed a maximum length class between 60 and 70 mm, in the northern sector, and between 30 and 40 mm, in both eastern and western sectors (Fig. 3). The width of the individuals showed a maximum width class between 30 and 50 mm in the northern sector, between 30 and 40 mm in the eastern sector and between 20 and 30 in the western sector (Fig. 3).

The ANOVA results showed significant differences between the sectors of the islet (**Tab. 1**). The *P. ferruginea* specimens of the western sector are less long than those of the eastern ($F_{(1,70)}$ = 6.17; P = 0.015) and northern ($F_{(1,54)}$ = 13.02; P = 0.0006) sectors, and less large than the northern sector ($F_{(1,54)}$ = 9.03; P = 0.004). No significant differences were observed between the eastern and the northern sectors both in length and width.

The length - width regression plots and equations are presented in **Fig. 4**. The biometric relationships between length and width showed differences between the sectors.

The average density value for the rocky sectors (~470m) is 0.24 individuals/meter. The χ^2 (d.f. = 2) highlights that the number of limpets per linear meter is much higher on the northern sector than on the other two sectors: χ^2 =7.1; P<0.05.

Discussion

The presence of *Patella ferruginea* in the National Park of Al Hoceima has been reported previously (METAP/Plan Bleu - SECA, 1993) on the basis of limited observations of specimens of exceptional size. A large population of *P. ferruginea* was observed in the study area and in particular along the Cala Iris Islet coasts. The number of specimens recorded on the Cala Iris Islet are worthy of notice when compared to those of sites with larger surfaces: 112 in Alboran Island (~ 2000m of shoreline; Paracuellos *et al.*, 2003) and 199 in Chafarinas Islands (Aparicio-Seguer *et al.*, 1995). The length mean value of the Cala Iris assemblage is lower than that of the Chafarinas Islands (59.3mm) and Ceuta (48.94mm).

The non homogenous distribution of *Patella ferruginea* on the Cala Iris Islet could be in relation to the sea wave exposition. The northern sector of the islet, where density of limpets are the highest, could be more exposed than the eastern and

Sector of the islet	Length (mm)			Width (mm)		
	Mean ± SE	DF	F	Mean ± SE	DF	F
North	5.02 ± 1.49	2	5.48**	3.94 ± 1.33	2	4.21*
East	4.61 ± 1.54			3.54 ± 1.27		
West	3.67 ± 0.80			2.93 ± 0.70		

Tab. 1. One-way ANOVA results for the influence of the location on the size of *Patella ferruginea* of the Cala Iris Islet. Significativity: * P<0.05; ** P<0.01.

Tab. 1. Risultati del test ANOVA one-way per l'influenza della località sulle dimensioni di *Patella ferruginea* nell'isoletta di Cala Iris. Significatività: * P<0.05; ** P<0.01.

western sectors of the islet where less specimens of the species were recorded by linear meter. This agrees with other data on the species which traditionally associates it with rocky shores exposed to a medium / strong wave action; well oxygenated waters and low levels of pollution (Aversano, 1986; Laborel-Deguen & Laborel, 1991b; Porcheddu & Milella, 1991). The distribution of the species size on the islet, with the highest number of size class individuals in 60 -70 mm range in the northern sector, and 30 - 40 mm in the eastern and western sectors certainly indicates a mixed presence of adult females and reproductive males since *P. ferruginea* is a proteandric species, being initially male (from 25mm in length) and subsequently female (from 40mm length) (Frenkiel, 1975). It also suggests that the northern sector is the one with most optimal conditions thereby allowing the survival of the highest number of individuals of all sizes. No juveniles were observed upon the specimens of *Patella ferruginea* during this study which may be explained by the fact that the observations were conducted outside of the breeding season.

The density recorded in the Cala Iris Islet is lower than those recorded in Chafarinas Islands (5.65 ind./m; Aparici-Seguer *et al.*, 1995), Habibas Islands in Algeria (4.5 ind./m; Boumaza & Semroud, 2001), Ceuta (0.67 ind./m; Guerra-Garcia *et al.*, 2004), Corsica (0.79 ind./m; Laborel-Deguen & Laborel, 1991b), and Zembra Island in Tunisia (0.7 ind./m; Boudouresque & Laborel-Deguen, 1986), while it is higher than that of the Alboran Island (0.06 ind./m, Paracuellos *et al.*, 2003).

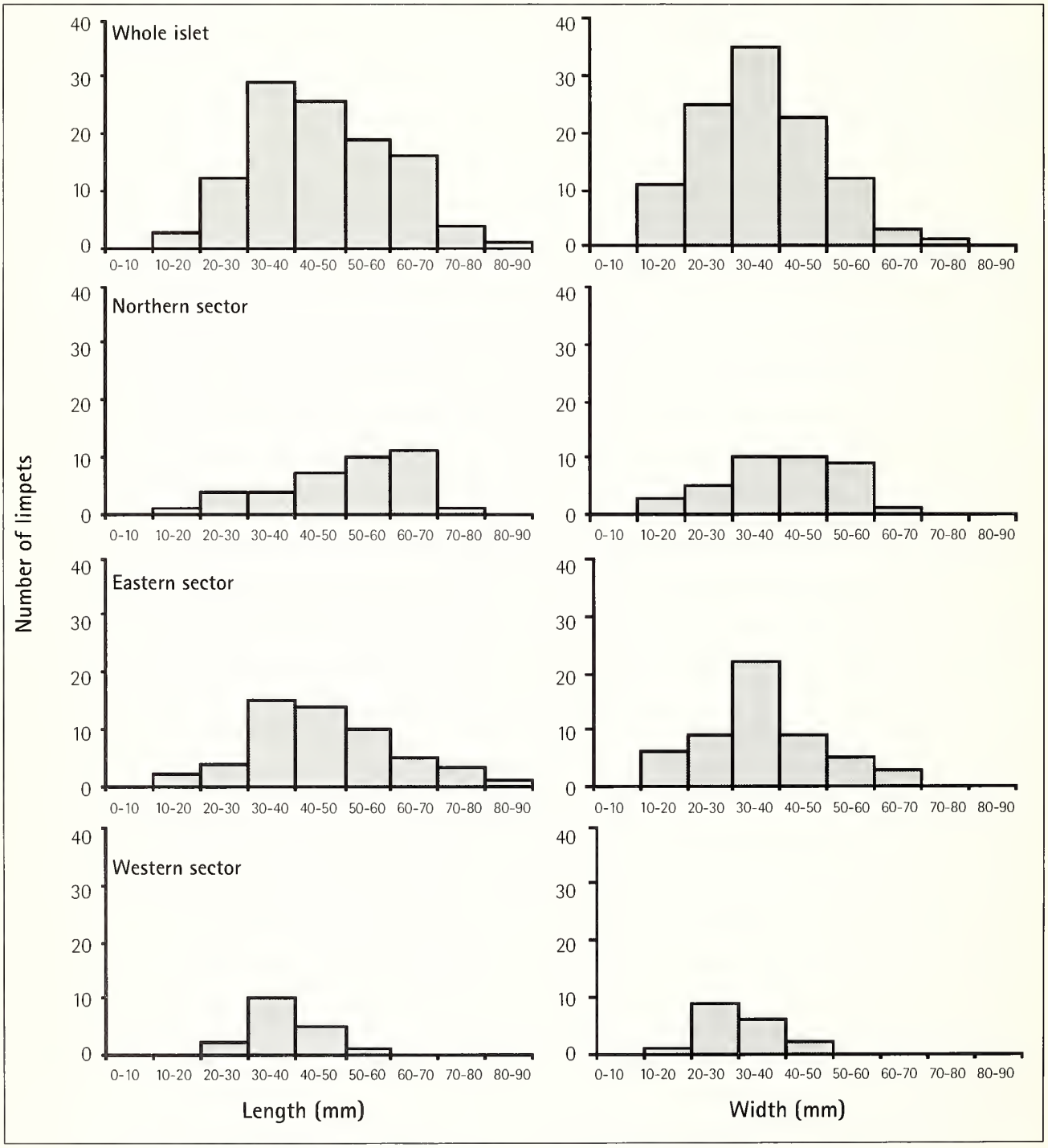

Fig. 3. Length and width frequency distribution of *Patella ferruginea* from the Cala Iris Islet.

Fig. 3. Diagrammi di frequenza delle lunghezza e larghezza di *Patella ferruginea* dall'isoletta di Cala Iris.

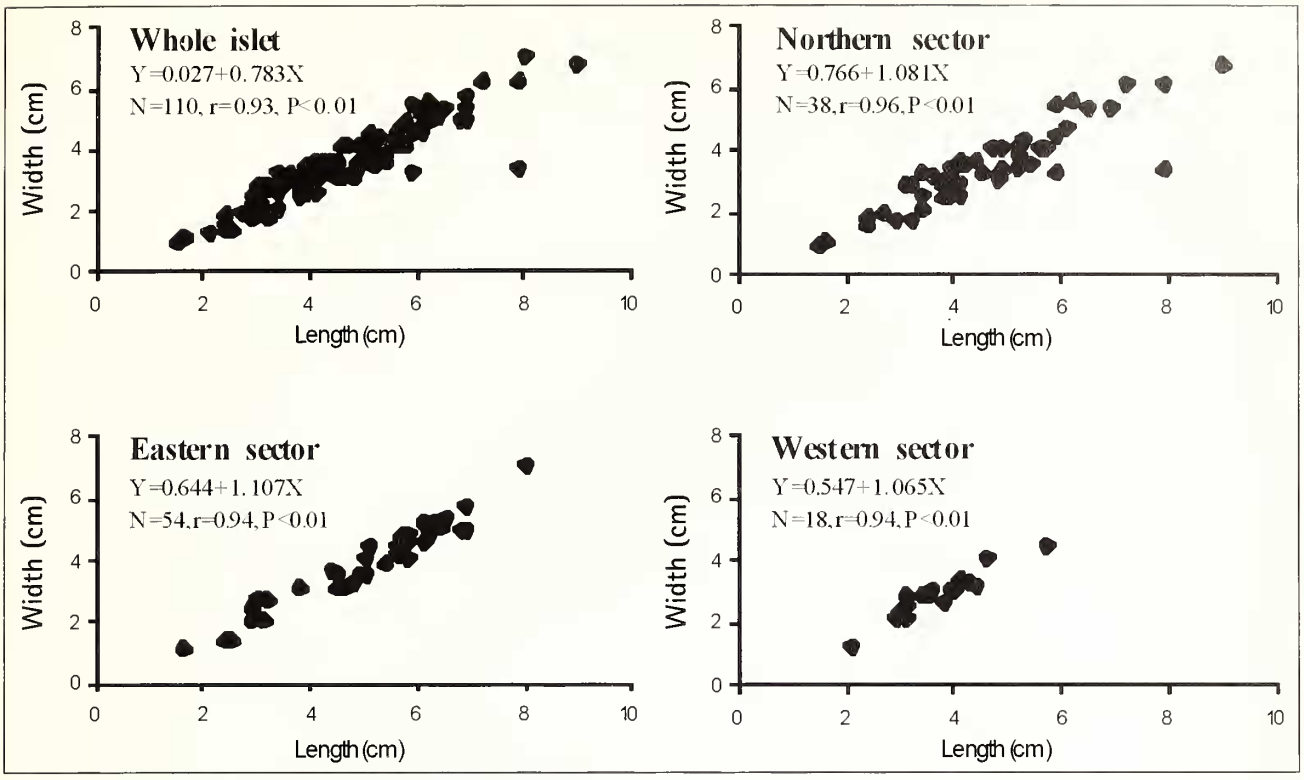

Fig. 4. Length vs width regression plots of *Patella ferruginea* from the Cala Iris Islet.

Fig. 4. Diagrammi di regressione tra lunghezza e larghezza in *Patella ferruginea* dall'isoletta di Cala Iris.

Although the density of limpets in the study area is not the highest recorded in the western Mediterranean, the geographic location represents a useful means for the dispersal and repopulation of the species throughout its former distribution range.

The coastal stretch of the National Park of Al Hoceima seems particularly interesting for *P. ferruginea*. The relevance of Al Hoceima region for this Mediterranean endangered species indicates the need to carry out further specific research activities inside the National Park of Al Hoceima. Such studies should be carried out with the aim of identifying a conservation strategy for the species, including a management and monitoring plan adequate for *Patella ferruginea* in the National Park of Al Hoceima.

References

Aparici-Seguer V., Guallart-Furio J. & Vicent-Rubert J.J., 1995. *Patella ferruginea* population in Chafarinas Islands (Alboran Sea, Western Mediterranean). In: Guerra A. Rolan E. & Rocja F. (Eds), Abstracts, Twelfth International Malacalogical Congress. Instituto de Investigaciones Marinas (CSIC), Viga: 119-121.

Aversano F.R., 1986. Esperimento di insediamento artificiale di *Patella ferruginea* Gmelin, 1791 nelle acque del Golfo di Arzachena (Sardegna settentrionale). *Balletino Malacalogica*, **22**: 169-170.

Bazairi H. & Benhissoune S., 2004. Présence de *Patella ferruginea* Gmelin, 1791 (Gastropoda, Patellidae) en Méditerranée marocaine: situation actuelle et perspectives. *Rappart du Congrès de la Commission Internationale pour l'Exploration Scientifique de la Mer Méditerranée*, **37**: 489.

Biagi V. & Poli D., 1986. Considerazione su una popolazione di *Patella ferruginea* Gmelin, 1791 per le acque del Promontorio di Piombino. *Ballettino Malacalogica*, **22**: 171-174.

Bouoouresque C.F. & Laborel-Deguen F., 1986. *Patella ferruginea*. In: Bouoouresque C.F., Harmelin J.G. & Jeuoy de Grissac A. (Eds.), *Le benthos marin de l'île de Zembra (Parc National, Tunisie)*. GIS Posidonie Publishers, Marseille: 105-110.

Bouoouresque C.F., 1996. *Impact de l'homme et conservation du milieu marin en Méditerranée*, 2° édition, GIS Posidonie publishers, Marseille, 243 pp.

Boumaza S. & Semrouo R., 2001. Inventaire de la population de *Patella ferruginea* Gmelin, 1791 des îles Habibas (Ouest Algérien). *Rappart du Congrès de la Commission Internationale pour l'Exploration Scientifique de la Mer Méditerranée*, **36**: 361.

Cretella M., Scillitani G., Toscano F., Turella P. & Picariello O., 1994. Relationships between *Patella ferruginea* Gmelin, 1791 and the other Tyrrhenian species of *Patella* (Gastropoda: Patellidae). *Journal of Malluscan Studies*, **60**: 9-17.

Fischer-Piette E., 1959. Contribution à l'écologie intercotidale du Détroit du Gibraltar. *Bulletin de l'Institut Océanographique*, **1145**: 1-32.

Frenkiel L., 1975. Contribution à l'étude des cycles de reproduction des Patellidae en Algérie. *Pubblicazione della Staziane Zoologica di Napoli*, **39**: 153-189.

Granofils R., 1982. Contribucion al conocimiento de *Patella ferruginea* (Gmelin, 1791). *Iberus*, **2**: 57-69.

Guerra-Garcia J.M., Corzo J., Espinosa F., & Garcia-Gomez J.C., 2004. Assessing habitat use of the endangered marine mollusc *Patella ferruginea* (Gastropoda, Patellidae) in northern Africa: preliminary results and implications for conservation. *Biological Conservation*, **116** (3): 319-326.

Laborel-Deguen F. & Laborel J., 1991a. Statut de *Patella ferruginea* Gmelin en Méditerranée. In: Boudouresque C.F., Avon M. & Gravez V. (Eds), *Les espèces marines à protéger en Méditerranée*, GIS Posidonie Publishers, Marseille: 97-103.

Laborel-Deguen F. & Laborel J., 1991b. Nouvelles observations sur la population de *Patella ferruginea* Gmelin de Corse. In: Bouoouresque C.F., Avon M. & Gravez V. (Eds.), *Les espèces marines à protéger en Méditerranée*, GIS Posidonie Publishers, Marseille: 119-128.

Maurin H. (dir.) 1994. *Le livre rouge: inventaire de la faune menacée en France*. Nathan, Muséum National d'Histoire Naturelle et Fonds mondial pour la nature (WWF-France), Paris, 176 pp.

METAP/Plan Bleu – SECA, 1993. *Parc National d'Al Hoceima: Plan directeur d'Aménagement et de Gestion*, 190 pp.

Muniz-Solis R., 1972. El genero *Patella* y su dispersion en las costas marroquies. *Cuadernos de la Biblioteca Espa_ola de Tetuan*, **6**: 47-77.

Pallary P., 1902. Liste des Mollusques testacés de la Baie de Tanger. *Journal de Conchyliologie*: 1-39.

Pallary P., 1912-1920. Exploration scientifique du Maroc, Malacologie. *Archives Scientifiques de l'Empire Chérifien*, II, 108 pp.

Paracuellos M., Nevaoo J.C., Moreno D., Giménez A. & Alesina J.J., 2003. Conservation status and demographic characteristics of *Patella ferruginea* Gmelin, 1791 (Mollusca, Gastropoda) on the Alboran Island (Western Mediterranean). *Animal Biodiversity and Conservation*, **26** (2): 29-37.

Porcheddu A. & Milella I., 1991. Aperçu sur l'écologie et sur la distribution de *Potello ferrugineo* (L.) Gmelin, 1791 en mers italiennes. In: Boudouresque C.F., Avon M. & Gravez V. (Eds.), *Les espéces morines ò protéger en Méditerronée*, GIS Posidonie Publishers, Marseille: 105-117.

Ramos M.A., 1998. Implementing the Habitats Directive for mollusc species in Spain. *Journol of Conchology Speciol publicotions*, **2**: 125-132.

Templado J., 2001. *Potello ferrugine*o Gmelin, 1791. In: Ramos M.A., Bragado D. & Fernandez J. (Eds), *Los invertebrodos no insectos de lo Directivo Hobitots en Espoño*, Serie Técnica, Organismo Autonomo Parques Nacionales (Direccion General de Conservacion de la Naturaleza, Ministereo de Medio Ambiente), Madrid: 41-49.

Lavoro ricevuto il 25 febbraio 2004
Lavoro accettato il 15 settembre 2004